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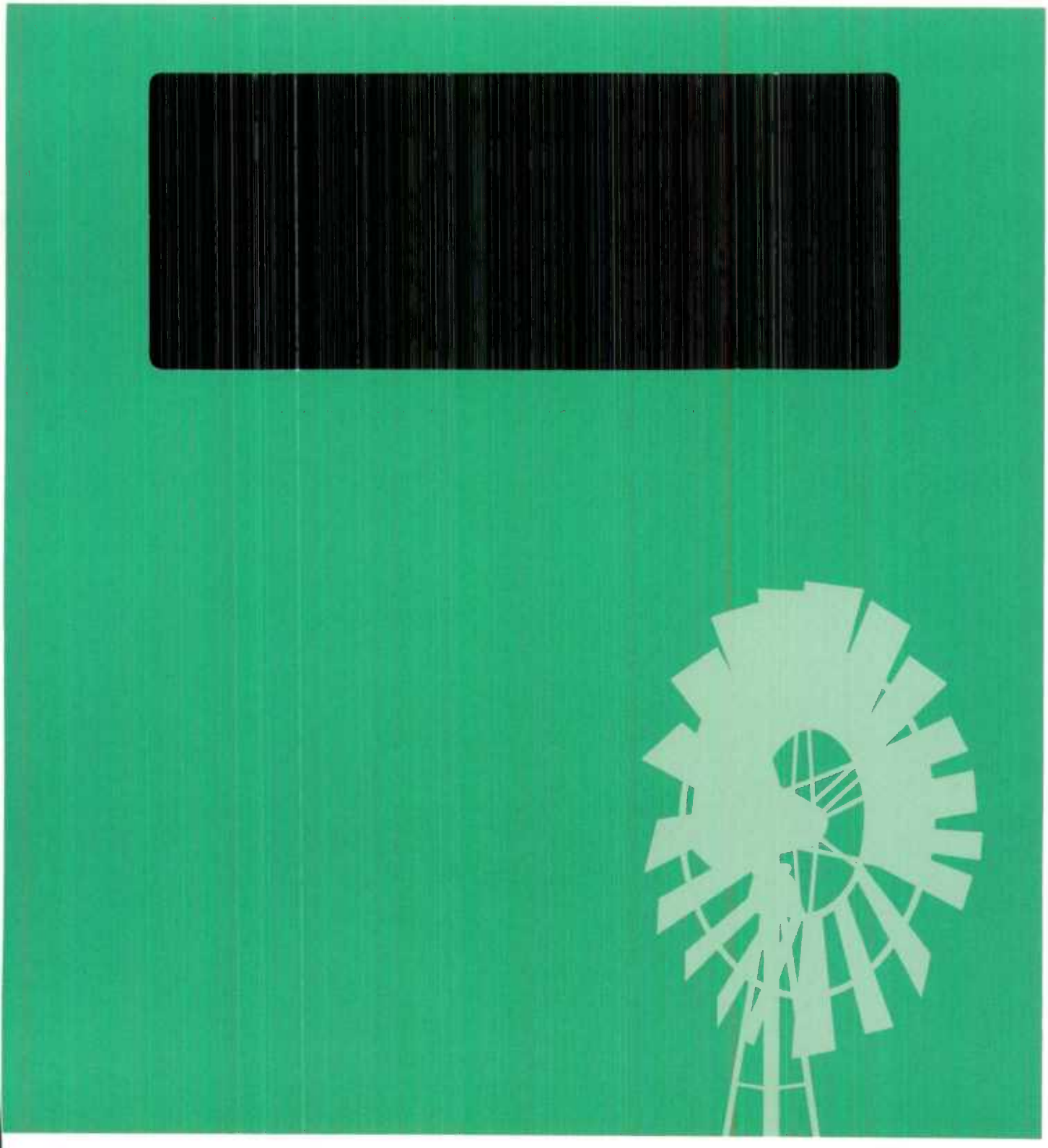

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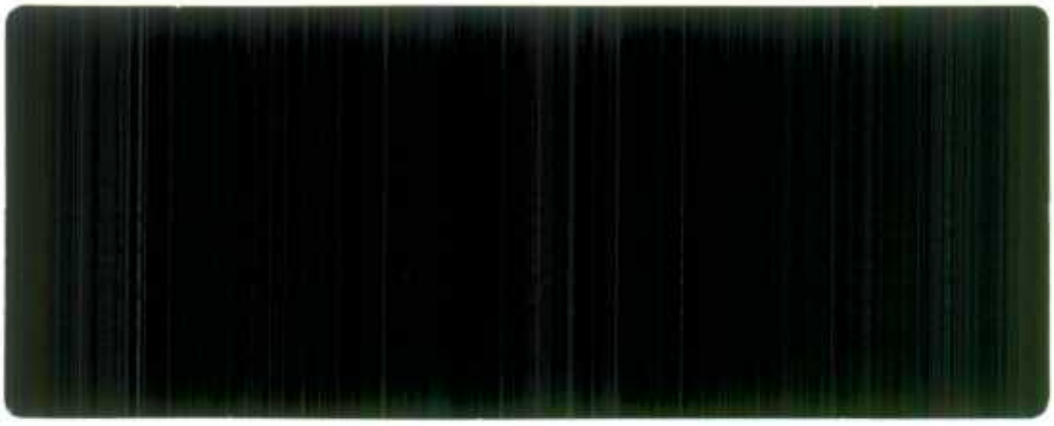

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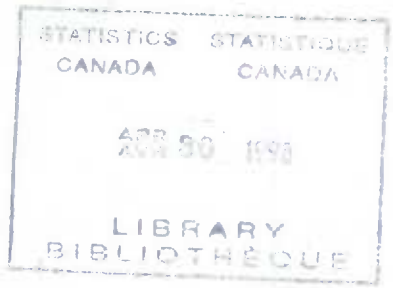
WORKING PAPER #12

The Impact of Geographic Distortion due to the Headquarters Rule



Rick Burroughs, Agriculture Division
Statistics Canada
1991

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THE IMPACT OF GEOGRAPHIC DISTORTION DUE TO THE HEADQUARTERS RULE

INTRODUCTION

The most frequent type of error encountered in sub-provincial Census of Agriculture data can be traced to a convention referred to as the headquarters rule. There is likely to be some error of this type in any number tabulated below the province level. Despite the frequency, few users are aware of it nor are they likely discover any evidence of it without careful scrutiny of the data.

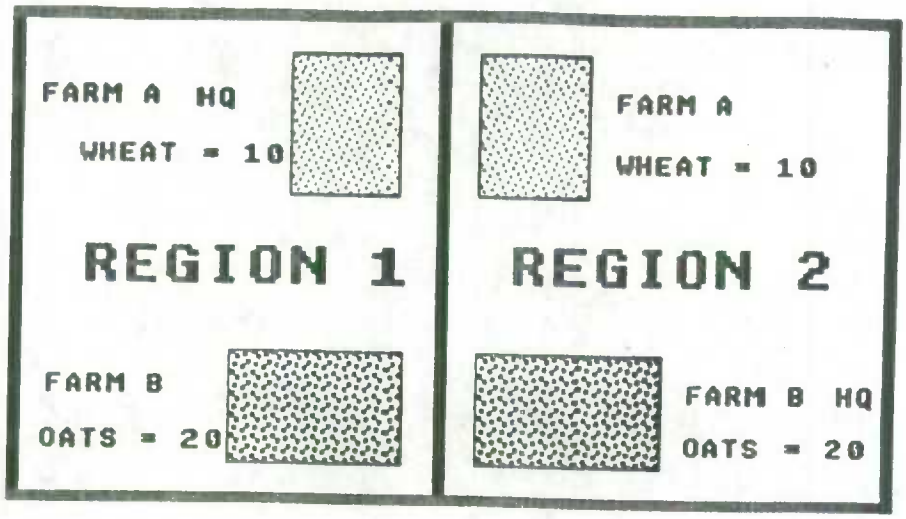
The careful user of the published data might notice in a couple of Saskatchewan census divisions that the total area of farms is slightly larger than the geographical area of the entire census division. This will be brought to the attention of Census of Agriculture staff perhaps twice during the five year census cycle. This paper will explain how this error is introduced into the data, outline the factors that influence its impact and examine the effects on the data for two study areas using data from the 1986 Census of Agriculture.

THE HEADQUARTERS RULE

It is common for farms in Canada to be composed of more than one parcel of land. The data collected on the questionnaire refers to the whole operation without allocating any of the variables among the various parcels of land. The only information collected with respect to each parcel of land is the legal description and the total area. The fundamental problem is posed when a geographic reference point is attached to this data. How are the data to be allocated among the parcels of land? In practise, the convention is to attribute all data to the parcel of land designated as the headquarters by the operator regardless of the location of any other parcels of land in the operation.

While this approach avoids the complexities of allocating data among the parcels of land, it introduces errors into the resulting tabulations. Figure 1 illustrates how this happens. Consider a simplified agricultural economy consisting of two farms (A & B), two regions (1 & 2), and two crops (wheat & oats). Farm A, with its headquarters in Region 1, operates two parcels of land, one in each region, and each parcel has an area of 10 acres all sown to wheat. Farm B has its headquarters in Region 2 and operates a 20 acre parcel of land in each region both sown to oats. If the land and crop areas were derived by observation of the diagram (land based approach as most users assume) then each region would have a total farm area of 30 acres broken down into 10 acres of wheat and 20 acres of oats. If the land and crop

FIGURE 1



	TOTAL	WHEAT	OATS
REGION 1			
AREA LAND BASED	30	10	20
AREA HQ BASED	20	20	0
DIFFERENCE	-10	+10	-20
REGION 2			
AREA LAND BASED	30	10	20
AREA HQ BASED	40	0	40
DIFFERENCE	+10	-10	+20

areas are derived using the headquarters convention, somewhat different results are obtained. Since only Farm A has a headquarters in Region 1, then the only areas that can be attributed to Region 1 are the two 10 acre wheat parcels. Similarly, in Region 2, only the two 20 acre parcels of oats from Farm B can be attributed. The differences between the land based value and the headquarters based value are termed the distortion due to the headquarters rule. Note that the sum of the distortions over the two regions is zero for each variable (i.e. land, wheat and oats).

FACTORS THAT INFLUENCE THE AMOUNT OF DISTORTION

The following are the factors that determine the amount of distortion which will occur.

Boundary Location

The distortion illustrated in Diagram 1 resulted from the situation where the parcels of land within the farm operation were separated by the boundary between the two regions. If the boundary does not separate parcels of land within the same farm operation, then no distortion will occur. The Manitoba/Ontario border is an example where no distortion is likely to occur, while the Manitoba/Saskatchewan border is an example where distortion is likely to occur.

The Distance Between Parcels

The greater the distances between the headquarters parcel and the other parcels, the greater the risk that a boundary will separate them.

The Number of Parcels

The greater the number of parcels within the operation, the greater the risk that one or more will be separated by a boundary.

The Length of the Boundary

The longer the boundary, the greater the risk that it will separate parcels of land from their headquarters.

The Value of the Variable Associated with the Separated Parts

The amount of distortion in a given variable increases with the value of the variable associated with the separated parcel. If oats is growing on a separated parcel, then the greater the area of oats in that parcel, the greater the distortion of the oats variable. If there is no oats growing on the separated parcel, then the distortion of the oats variable will be zero.

CASE STUDY I - CHESTER, SASKATCHEWAN

Chester is a rural municipality in south-eastern Saskatchewan. In the 1986 Census of Agriculture, the farm area published (under the headquarters rule) was slightly higher than the geographical area within its boundaries. For this reason it was selected as the starting point of the investigation.

Its legal description declares Chester to be Saskatchewan Rural Municipality #125 consisting of nine townships (Townships 13,14 & 15, Ranges 7,8 & 9 west of the second meridian. Its physical dimensions are exactly 18 miles by 18 miles.

The approach to measuring the distortion in the total farm area requires two measurements. The first is termed the positive distortion. This is the area of parcels of land which are not located in Chester but are associated with farm operations with a headquarters in Chester. This measurement was obtained by recording the area of all such parcels as reported on the questionnaires with headquarters in Chester. The second measurement is termed the negative distortion and refers to the area of parcels of land which are located in Chester but are associated with farm operations with a headquarters located outside of Chester. This measurement could also have been taken from the questionnaires, however it would require looking at more than a thousand of them in all the neighbouring municipalities. It was much simpler to derive it from information already at

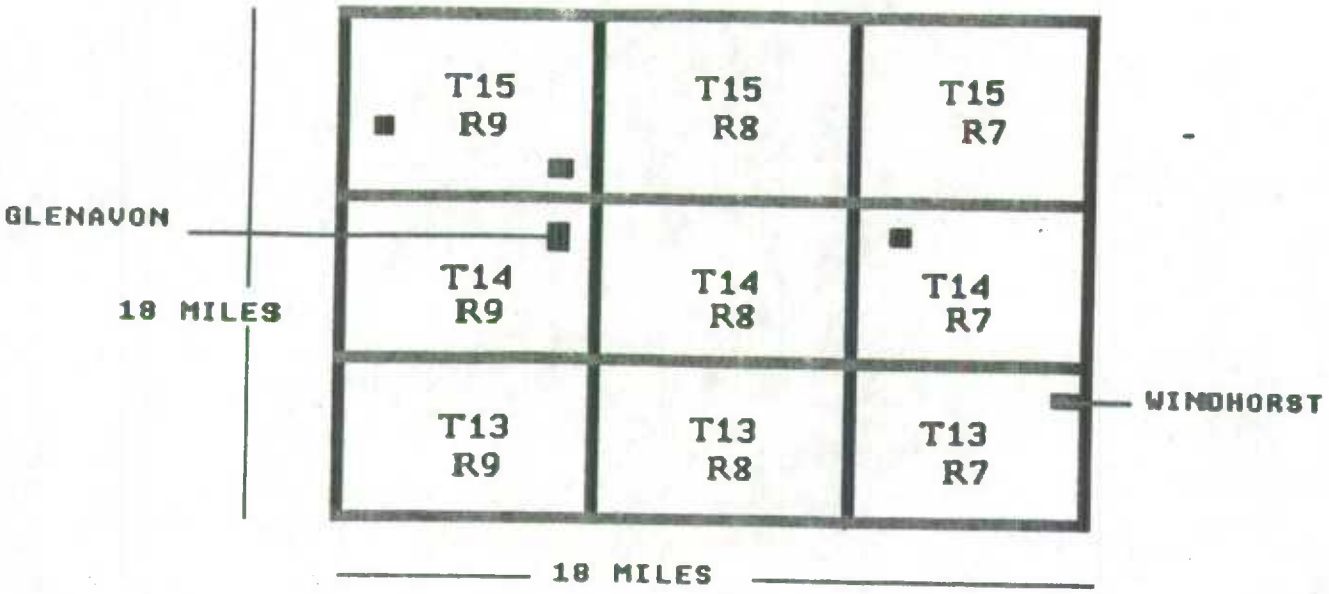
hand. The method is explained in the Appendix.

Figure 2 presents the results. The area of Chester was 207,360 acres. It contained the headquarters of 220 farms with a farm area totalling 207,958 acres. This is the result of a positive distortion of 22,326 acres and a negative distortion of 20,608 acres on a land based area of farms of 206,240 area. The important things to notice are:

1.)The area of farms is greater than the area of the municipality because the positive distortion is not completely offset by the negative distortion and the fact that virtually the entire area of the municipality is agricultural.

2.)While the net impact of the distortion on farm area is relatively small, the size of the positive and negative distortions (more than 10% each) is significant.

FIGURE 2



MAP OF CHESTER #125

	AREA ACRES	FARMS REPORTING
AREA OF LAND	207,360	-
AREA OF FARMS WITH HQ IN #125	207,958	220
AREA ATTRIBUTED BUT NOT IN #125	22,326	44
AREA IN #125 BUT NOT ATTRIBUTED	20,608	N/A
LAND BASED AREA OF FARMS	206,240	-
PERCENT CHANGE	1	

CASE STUDY II - LOT 19, PRINCE EDWARD ISLAND

Lot 19 in Prince Edward Island represents a contrast to the situation in Chester. The type of agriculture is different. The cadastral organization is different. The farms are generally smaller in area. Would the distortions be as large in these circumstances?

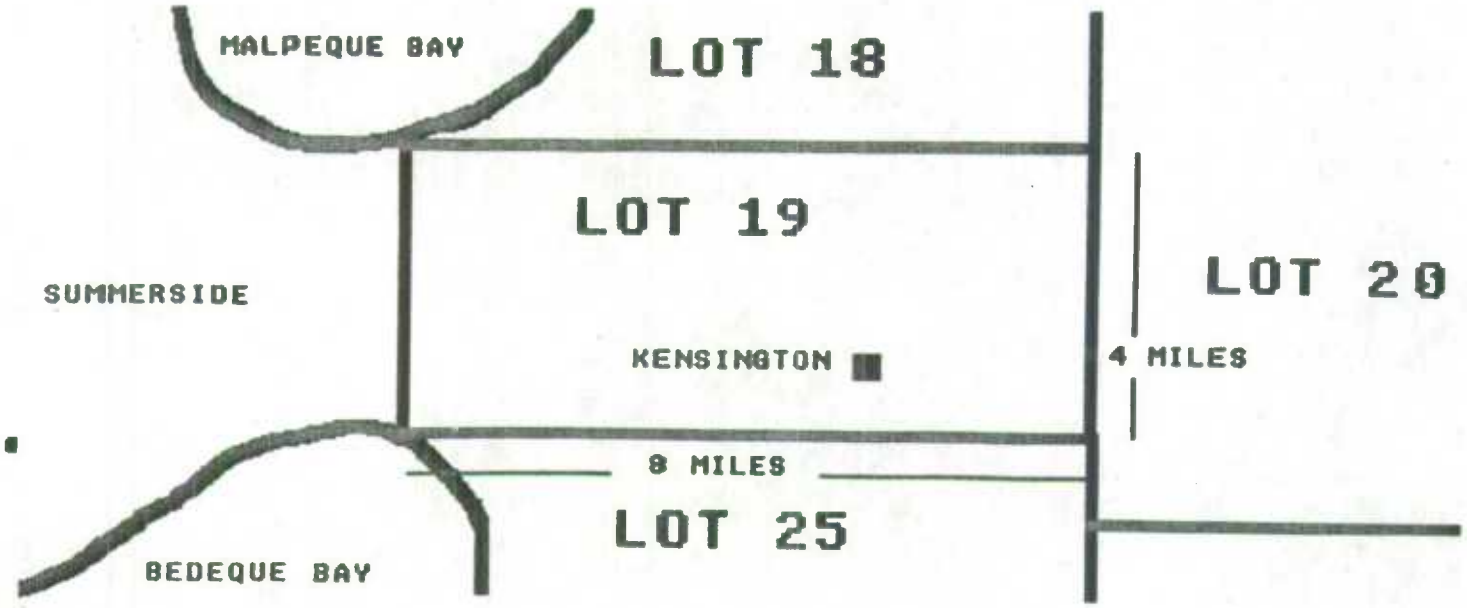
The method used was similar to that described in Chester except that the negative distortion was measured using the questionnaires rather than the equations. The amount of work was considerably less than the case in Chester.

Prince Edward Island municipal data is published by lots. These lots are considerably smaller than RM's in Saskatchewan. Lot 19 is approximately 8 miles by 4 miles and is about 60% agricultural. It is bounded by the city of Summerside on the west and three other rural lots on the north, east and south.

The results of the study are presented in Figure 3. The total area of Lot 19 is estimated at 20,352 acres. It contains the headquarters of 62 farms with a farm area of 12,598 acres. The positive distortion was calculated at 3,355 acres and the negative distortion came out to 3,336 acres.

Since the number of farms associated with the distortions was relatively small, a deeper investigation was performed. It

FIGURE 3



MAP OF LOT 19

	AREA ACRES	FARMS REPORTING
AREA OF LAND	20,352	-
AREA OF FARMS WITH HQ IN LOT 19	12,598	62
AREA ATTRIBUTED BUT NOT IN LOT 19	3,355	13
AREA IN LOT 19 BUT NOT ATTRIBUTED	3,336	19
LAND BASED AREA OF FARMS	12,579	-
PERCENT CHANGE	0	

revealed that three farm operations have a large impact. These operations had large holdings of land in Lot 19 and in surrounding lots as well. Their headquarters were located in Lot 19. Figure 4 presents the land area data for Lot 19 as if the operators of these farms had chosen a parcel of land in another lot as the headquarters. The area of farms under the headquarters rule drops by 28%. The positive and negative distortions become considerably unbalanced.

Up to this point, the total farm area has been the only variable discussed as it is the only information on the questionnaire for each parcel. The study of distortion in other variables would require small area land-based information from another source. The satellite imagery in the Remote Sensing Unit of the Crops Section was suitable and readily available.

They had a satellite image of Prince Edward Island taken in the growing season season of 1986. The unit also had considerable experience estimating the area of potatoes from these images in recent years. They outlined the boundaries of each potato field in Lot 19 and calculated the area. The result was a land-based estimate of potato area of 3,568 acres. The comparable headquarters-based value produced by the Census of Agriculture was 3,764 acres.

FIGURE 4

MOVE THE HEADQUARTERS OF THREE FARMS FROM LOT 19 TO NEIGHBOURING LOTS . . . . . .

	AREA ACRES	FARMS REPORTING
AREA OF LAND	20,352	-
AREA OF FARMS WITH HQ IN LOT 19	9,064	59
AREA ATTRIBUTED BUT NOT IN LOT 19	774	10
AREA IN LOT 19 BUT NOT ATTRIBUTED	4,289	22
LAND BASED AREA OF FARMS	12,579	-
PERCENT CHANGE	-28	

The important things to note from this case study are:

1.) As in the case of Chester, the net distortion of farm area was relatively small. Likewise the positive and negative distortions were of significant proportions, and more than double the proportions calculated in Chester.

2.) The impact of the three large farm operations in Lot 19 was enough to drastically alter the area of farms and the balance of the positive and negative distortions.

3.) The 196 acre difference (5 %) between the land-based and headquarters-based estimates for the area of potatoes demonstrates that a measure of distortion for one variable is not a reliable indicator of the distortion of another variable.

FINDINGS

The findings of this research are as follows:

1.) The amount of distortion at the small area level can be significant although the net impact may appear to be

negligible.

2.) Large operations can produce large distortions.

3.) The distortion of one variable is not necessarily related to the distortion of another.

4.) Distortion is a function of several factors not all of which are easily measured.

Some users may regard the small net distortions observed in this paper as of little consequence. Others may point to the relative size of the positive and negative distortions and consider them cause for serious concern. The recommended approach is to assess each situation separately.

For example, there is no need to be concerned for provincial level data. The risk tends to increase with each successive level of geographic disaggregation. Similarly, for variables which are commonly reported in an area, the tendency for positive and negative distortions to balance is to be expected. Also, in areas where farms are smaller than average in size, the tendency for farms to consist of multiple parcels is reduced. The user's assessment of the risk and its possible impact in each application should govern the use of the data.

APPENDIX

Method for Estimating Negative Distortion in Case Study 1

Negative distortion can be estimated in the areas covered by township plans in the Prairie Provinces using two equations as follows:

Equation 1 $TLA = NALA + AGLA$

where TLA = total land area

NALA = non-agricultural area

AGLA = agricultural area

Equation 2 $AGLA = AGLA(HQ) - PD + NG$

where AGLA(HQ) = agricultural area under the headquarters rule

PD = positive distortion

ND = negative distortion

Substituting the right side of Equation 2 for AGLA in Equation 1 and solving for ND gives:

Equation 3 $$NG = TLA - NALA - AGLA(HQ) + PD$$

Data sources for the right side components of Equation 3 are:

TLA - legal description of the municipality

NALA - census enumerator's township plan

AGLA(HQ) - published farm area for the municipality

PD - recorded from the microfim records of the questionnaires

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